**Diagnostics upgrades for the RFX-mod2 facility for multi-magnetic-configuration exploration**

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The RFX-mod2 device [1], the upgraded version of RFX-mod, will start its operation in 2024 with improved magnetic boundary and diagnostic capabilities. The main device modification is the enhancement of the passive stabilizing shell to plasma proximity. This, coupled to the advanced active feedback control system, is predicted to significantly improve plasma performances in a variety of magnetic configurations, including the reversed-field pinch (RFP), the tokamak and the ultra-low q.

For a better characterization of plasma dynamics in all the accessible experimental conditions, several significant diagnostics improvements have been proposed and are presently under implementation.

These include the installation of >1000 in-vessel high frequency coils for the characterization of long and very-small scale magnetic fluctuations, of about 500 edge electrostatic probes, distributed throughout the toroidal and poloidal directions, for the analysis of the electron density, temperature, plasma potential and flow in the edge and of plasma-wall interaction and turbulence.

A higher repetition rate Thomson scattering system and a strengthened Soft X-ray diagnostics based on the double filter technique, will provide better reconstruction of the topology and the dynamics of the core thermal barriers, which form in helical RFP equilibria.

Multiple lines of sight neutron diagnostics based on fast inorganic and organic scintillators and a new Compact Neutral Particle diagnostic system are dedicated to the analysis of anomalous ion heating phenomena in RFP plasmas. A diagnostic neutral Beam (50keV) will investigate the evolution of the ion temperature profile. The electron distribution function will be energy, time and space resolved by means of a soft X-ray imaging system based on a GEM detector in a pinhole configuration.

A fast-reciprocating manipulator, housing systems of magnetic and electrostatic probes, will allow the exploration of the edge radial plasma profiles and turbulence even in high current RFP regimes and to characterize SOL and pedestal regions in H-mode tokamak shaped and circular plasmas.

An innovative reflectometric technique for plasma position in the tokamak will be tested.

The 3D pattern of the plasma wall interaction will be studied with a set of 7 cameras (500 fps) measuring the emission and the Carbon influx. The poloidal distribution of low Z impurities will be obtained with the Light Impurity Tomography (LIT). A cavity-based imaging polychromator designed to resolve 2D absolute intensity images of different emission lines with < 5mm resolution, named MANTIS [2], will gain information on the 2D pattern of electron density and temperature [3]. The edge radial profiles of ne and Te, will be studied with the Thermal Helium Beam [4,5]. The edge characterization is completed by measuring the edge fluctuations due to turbulence [6] thanks to the Gas Puff Imaging diagnostic, already present in RFX-mod.

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The complex arrays of magnetic coils, along with a system of distributed halo sensors, will allow to validate the electromagnetic modelling of the sideway forces during rapid transients in the tokamak. 1 L. Marrelli et al., Nucl. Fusion **59** (2019) 076027

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